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Successful Transfer of a Motor Learning Strategy to a Novel Sport

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Successful Transfer of a Motor Learning Strategy to a Novel

Sport

For Peer Review

SUCCESSFUL TRANSFER OF A LEARNING STRATEGY

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Abstract

This study investigated whether secondary school students taught a motor learning strategy could transfer their knowledge of the strategy to learning a novel task. Twenty adolescents were randomly allocated to a strategy or control group. The strategy group was taught Singer's five step learning strategy, while the control group received information on the evolution and biomechanics of the basketball free throw. Both groups received three one-hour practice sessions on a modified basketball shooting task. After one month, participants were introduced to the transfer task, golf putting. Performance accuracy was recorded for all tasks, and participants completed questionnaires regarding strategy use during practice. Participants taught the five step learning strategy successfully recalled and applied it after a one month interval, and they demonstrated superior performance on both acquisition and transfer tasks, relative to the control group. Physical education teachers and coaches should consider using this five step learning strategy to enhance the learning of closed motor skills.

Keywords

Transfer, practice effects, physical education effects, technique performance, coaching techniques

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1 Introduction

2 Learning strategies are combinations of thoughts and behaviours purposely initiated
3 by a performer in order to learn a novel, self-paced motor task with greater efficiency and
4 effectiveness (Lidor & Singer, 2005). Research within a range of contexts has revealed that
5 task-appropriate learning strategies can accelerate learning (DiBenedetto & Zimmerman,
6 2010; Lidor & Singer, 2005; McPherson & Zimmerman, 2002). Students have limited time
7 to practice during physical education (PE) classes (Graham, 2008), leading Lidor (1997,
8 2004) to propose that learning strategies be taught to accelerate learning physical skills and
9 to make more efficient use of PE class time.

10 Within the motor learning literature, the most-researched learning strategy has been
11 the Five Step Approach (5SA) (Singer, 1988; Singer & Cauraugh, 1985). The 5SA consists
12 of Readying, Imaging, Focusing, Executing, and Evaluating. During readying, the learner
13 adopts a mechanical, attitudinal and emotional position in which he/she can deliver a high
14 quality attempt. This step may involve adopting a particular posture, performing some
15 preparatory action such as a practice swing, or completing a breathing exercise. Next, in
16 imaging, the learner images the desired action and/or outcome. As with readying, there is
17 freedom within this step for the learner to adapt the nature of the imagery; for example, the
18 learner may adopt visual or kinaesthetic imagery. During the third step, the learner focuses

SUCCESSFUL TRANSFER OF A LEARNING STRATEGY

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1 their attention on one relevant cue, blocking out potential distractors. During the fourth step
2 the learner attempts to execute the skill without consciously guiding the movement or
3 outcome: just letting it happen. During the final step, the learner must evaluate both the
4 performance and how effectively the previous steps were applied (e.g., “was I ready to
5 undertake that attempt?”, “how clear an image did I form?”, etc). Although superficially
6 formal and rigid, there is flexibility within the 5SA to adapt each step to the needs and
7 experiences of the individual learner, whilst providing a clear framework to promote higher
8 quality practice.

9 The effectiveness of the 5SA has been established in a range of tasks, and with
10 diverse populations (for a review see Lidor & Singer, 2005). Initial lab studies
11 demonstrated that applying the 5SA led to superior performance and learning of simple
12 skills (e.g., Singer, Flora, & Abourezk, 1989; Singer, Lidor, & Cauraugh, 1994).
13 Subsequent research demonstrated the effectiveness of the 5SA with children (Lidor, 1997,
14 2004) and older adults (Steinberg & Glass, 2001), and in the performance of sporting tasks
15 in field contexts (Chung, Kim, Janelle, & Radlo, 1996; Lidor, Arnon, & Bronstein, 1999).
16 These initial field based studies varied in their methodological rigour; for example, Chung
17 et al. (1996) did not include a retention test, while neither Lidor et al. (1999) nor Chung et
18 al. (1996) included a manipulation check. However, Lidor (2004) addressed each of these

SUCCESSFUL TRANSFER OF A LEARNING STRATEGY

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9 1 limitations within a PE context by implementing detailed checks for understanding, adding
10 2 multiple manipulation checks, and including a retention phase. Lidor (2004) reported that
11 3 the 5SA resulted in superior learning compared to both a control group and to an alternative
12 4 learning strategy focused on enhancing awareness. In sum, past research, especially
13 5 including Lidor (2004), strongly supports the efficacy of the 5SA.

14 6 An important remaining question is whether individuals who have been taught the
15 7 5SA will apply it, unprompted, to learning subsequent tasks. To do so, learners would
16 8 presumably have to increase time spent on each new skill attempt (Cleary, Zimmerman, &
17 9 Keating, 2006; Lidor, 2004), and expend greater effort (Coughlan, Williams, McRobert, &
18 10 Ford, 2014), perhaps discouraging the application of the learning strategy. While a number
19 11 of studies have demonstrated that participants who learn the 5SA on one task appear
20 12 capable of transferring it to a novel task (Lidor, Tennant, & Singer, 1996; Singer,
21 13 DeFrancesco, & Randall, 1989; Singer & Suwanthada, 1986), a major limitation of these
22 14 studies is reliance on a short (five-minute maximum) time interval between learning the
23 15 strategy on an initial task and applying it to the transfer task. Such a short interval not only
24 16 provides a limited test of whether learners will transfer the strategy in real life situations,
25 17 but it also increases the risk of a social desirability confound (Crowne & Marlowe, 1960).
26 18 A second limitation of all three earlier studies was that no manipulation check of strategy

SUCCESSFUL TRANSFER OF A LEARNING STRATEGY

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1 use was conducted on the transfer task. Thus, this experiment aimed to establish whether
2 learners taught the 5SA could successfully retain and apply it and also proclaim a reliance
3 on it, after a one-month interval.

4 **Method**

5 **Setting and participants**

6 Following institutional ethical approval, participants were recruited from a school in
7 the South of England. Twenty participants (10 male, 10 female; 14-15 years old)
8 volunteered to participate through both parental and student written consent. All
9 participants claimed to be novices at both basketball and golf. Participants were randomly
10 assigned to either an experimental group, who were taught the five step approach, or a
11 control group who did not receive this intervention, with the proviso that each group
12 consisted of five male and five female participants.

13 **Task and measures**

14 During the acquisition phase, participants learned a modified basketball free throw
15 skill. Participants were required to throw underarm to a standard sized basketball ring from
16 a distance of three meters using a size 5 basketball (circumference 68 centimeters). Points
17 were awarded for each shot consistent with the scoring system introduced by Wallace and
18 Hagler (1979) in which five points were awarded for a shot which passed through the

SUCCESSFUL TRANSFER OF A LEARNING STRATEGY

1 basket without touching the ring, four points were awarded for a ball which passed through
2 the basket having first hit the inside of the ring, down to 0 points awarded for a ball that
3 made no contact with the ring or backboard.

4 During the transfer phase, participants practiced a golf putting task. This task was
5 chosen to reduce the risk that task similarity would result in either transfer of learning or in
6 participants from the strategy group being reminded of their instruction on the strategy.
7 Participants attempted to strike a standard golf ball into a circular target area (10
8 centimeters diameter) marked on an artificial putting mat from a distance of three meters
9 using a regulation putter (84 centimeters in length). The target area was surrounded by an
10 additional nine concentric circles, with the radius of each circle increasing by 10
11 centimeters as it progressed from the center. Ten points were awarded to putts that finished
12 within the center circle, with points decreasing by one for each successive circle away from
13 the target.

14 To determine strategy use, all participants completed researcher-devised
15 questionnaires after the acquisition phase. Due to an administrative error, after the transfer
16 phase the questionnaires were only delivered to the strategy group. In the questionnaires,
17 participants were asked to identify any thoughts or behaviours they used to enhance their
18 performance of the skill. Participants were also asked the origin of their strategies. In

SUCCESSFUL TRANSFER OF A LEARNING STRATEGY

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1 addition to this strategy use questionnaire, participants in the strategy group were
2 subsequently asked to complete a second questionnaire regarding the five step approach.
3 Specifically, participants were asked to name and explain the five steps, and to indicate
4 whether they intended to apply the strategy to the practice of other skills.

5 Procedure

6 The study was undertaken across four sessions (see Figure 1). The same researcher
7 taught both groups during the acquisition phase. On the first day of the acquisition phase,
8 all participants initially received a demonstration of the basketball task and an explanation
9 of the scoring system. Participants were subsequently provided with 10 familiarization
10 trials, followed by 10 pre-test trials. Participants then received a 20 minute briefing specific
11 to their group. Participants in the control group received information on the evolution and
12 biomechanics of the free throw, emphasising the advantages of the underarm method and
13 describing the success achieved by individuals who had utilised this approach. Participants
14 in the strategy group received a detailed explanation of learning strategies in general, and
15 the application of the five step approach to the underarm basketball free throw in particular,
16 after which the researcher answered participants' questions regarding the strategy. All
17 participants then completed three blocks of 10 underarm free throws. On each of the

SUCCESSFUL TRANSFER OF A LEARNING STRATEGY

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1 subsequent two days, following a review of the initial briefing, participants again
2 completed three blocks of 10 trials.

3 In an attempt to eliminate social facilitation (Rajecki, Ickes, Corcoran, & Lenerz,
4 1977) participants completed all trials individually. At the end of the third day, once they
5 had completed their final block of practice trials, participants from both groups first
6 completed the strategy use questionnaire. Once that questionnaire had been submitted,
7 participants in the strategy group were then asked to complete a second questionnaire
8 examining their knowledge of the five step approach.

9 After a one-month interval, the participants' regular PE teacher introduced the novel
10 golfing task. The researcher who taught the students during the acquisition phase was not
11 present. Following a demonstration of the putting task and an explanation of the scoring
12 system, each participant completed 10 familiarisation trials followed by 30 additional
13 practice attempts (three blocks of 10 trials). Participants were again tested individually. On
14 completion of the 30 trials, participants from the strategy group were asked to complete the
15 strategy use questionnaire, and knowledge of the five step approach was then assessed as
16 per the acquisition phase.

17 **Data Analysis**

SUCCESSFUL TRANSFER OF A LEARNING STRATEGY

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10 1 Due to the relatively small numbers within each group, non-parametric tests were
11 2 applied to the performance data (Fallowfield, Hale, & Wilkinson, 2005). The statistical
12 3 analyses were performed using IBM SPSS Statistics Version 22. Data on the initial
13 4 basketball task (pre-test and acquisition days 1-3) were analysed using separate Friedman's
14 5 ANOVAs for each group. In addition, between group comparisons of performance on the
15 6 pre-test, and on each day of acquisition, were performed using Holm-Bonferroni corrected
16 7 Mann-Whitney U tests. As the scoring system for the transfer task was substantially
17 8 different from that for the initial basketball task, an additional Mann-Whitney U test
18 9 compared performance between groups on the transfer test. Alpha was set to 0.05.
19 10 Pearson's correlation coefficient (r) provided a measure of effect size (Field, 2005).

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33 11 Responses to the strategy use questionnaire were independently coded by the two
34 12 researchers. Responses were coded to Readying if the participant made reference to any
35 13 preparatory action or behavior, such as adopting a particular stance or taking a deep breath.
36 14 Responses were coded to Imagery if the participant made reference to imaging the action or
37 15 the outcome. Responses were coded to Focus if the participant identified one aspect of the
38 16 task on which they directed their gaze or their attention. Responses were coded to Execute
39 17 if the participant made reference to completing the action with a clear mind or without
40 18 thought for the specifics of the action. Finally, responses were coded to evaluate if the
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SUCCESSFUL TRANSFER OF A LEARNING STRATEGY

1 participant made reference to thinking about changing an element of their preparation or
2 execution. An additional category, Technique, was established, as many of the participants
3 in the control group reported thinking about specific aspects of technique during the
4 execution of the throw (e.g., “Flick my hands back to create spin on the ball whilst keeping
5 supple elbows and strong wrists”, participant 15). Initial inter-rater agreement (calculated
6 as the number of agreements divided by the total number of agreements plus
7 disagreements) for the six categories ranged from 87-100%. Any disagreements in coding
8 were discussed until agreement was reached. Responses to the strategy knowledge
9 questionnaires were evaluated independently by the two researchers. Percent agreement,
10 calculated as per the strategy use questionnaire, was 100%.

Results

Performance

13 Descriptive statistics are presented in Table 1. Analysis of the performance of the
14 control group on the basketball task showed no significant change in performance across
15 the acquisition period, $\chi^2_3 = 3.24, p = 0.356$. In contrast, the strategy group showed a
16 significant improvement in performance from the pre-test to the end of the acquisition
17 period, $\chi^2_3 = 26.51, p < 0.001$. Holm-Bonferroni corrected Mann-Whitney U tests revealed
18 that there was no significant difference between the control group (Median = 2.45 points,

SUCCESSFUL TRANSFER OF A LEARNING STRATEGY

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1 IQR = 0.82) and the strategy group (Median = 2.30 points, IQR = 0.38) on pre-test, $z =$
2 1.179, $r = 0.26$, $p = 0.247$, but that the strategy group recorded superior performances on
3 day 2 ($z = -2.31$, $r = 0.52$, $p = 0.019$) and day 3 ($z = -2.50$, $r = 0.56$, $p = 0.011$) of
4 acquisition (see Table 1). On the transfer test, the strategy group (Median = 5.3 points,
5 IQR = 0.46) performed significantly more accurately than the control group (Median = 4.9,
6 IQR = 0.76), $z = -2.43$, $r = 0.54$, $p = 0.015$.

7 Strategy Use

8 Figure 2 illustrates the strategies reported by the participants. The majority of
9 participants in the strategy group reported using all five steps during the acquisition phase.
10 For example, participant four reported:

11 “I bounced the ball three times and took two deep breaths to calm my nerves. I
12 focused on the back of the rim. I imagined myself throwing the ball confidently and
13 fluently. I cleared my mind and threw. Once thrown, I reviewed my throw and
14 changed the negative points.”

15 During the transfer phase, only half of the strategy group participants reported using
16 imagery, but the use of the other steps remained high. The order in which the steps were
17 reported often varied from that established by Singer & Cauraugh (1985). For example,
18 participant 10 reported:

SUCCESSFUL TRANSFER OF A LEARNING STRATEGY

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9 1 “Put ball in place – under me. Tight grip and looked at where want to place it.
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11 2 Imagined doing it and took a deep breath and hit it without thinking and evaluated
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13 3 performance.”
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16 4 In this example, Imagery is both preceded (ball placement, grip) and followed (deep breath)
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18 5 by steps that can be considered as Readying. Across both the acquisition and transfer
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20 6 phases, nine of the 10 participants in the strategy group reported some deviation from the
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22 7 proposed sequence of the 5SA, either in terms of swapping of steps (as in the earlier
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24 8 example from participant four), or in terms of repeating steps (typically readying) out of
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26 9 sequence (as in the example from participant 10).
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30 10 All 10 participants in the strategy group indicated that they would apply the 5SA to
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32 11 skills in the future. A number of reasons were given for this including: “It helped me get a
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34 12 regular routine before shooting” (participant 1), “It made me feel comfortable” (participant
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36 13 3), and “Made me feel confident” (participant 5). Furthermore, following the transfer phase,
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38 14 individual participants reported that they had begun to apply the skill in hockey, tennis
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40 15 (three participants), football, basketball, stool ball and “In everywhere I have time to”
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42 16 (participant 7).
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SUCCESSFUL TRANSFER OF A LEARNING STRATEGY

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1 Figure 2 indicates that participants in the control group also reported statements that
2 could be classified as belonging to one of the steps of the 5SA, although not as frequently
3 as participants in the strategy group. For example, participant 11 reported:

4 “I get my feet in the right position first and make sure my arms are slack and loose.
5 Make sure I extend my shoulders and spin the ball with my fingers. After I see if I
6 need to throw the ball further or not as far to make it more accurate.”

7 This participant’s report contains elements relating to the steps of Readyng (foot position,
8 loose arms) and Evaluation (I see if I need to...), as well as Technique (extend shoulders,
9 finger action). In this instance, the participant explained that the strategy originated with his
10 cricket coach, and is similar to what he thinks about when batting. The use of Readyng by
11 participants in the control group was not isolated to adopting an appropriate posture.

12 Participant 17 described a routine prescribed by her PE teacher in netball lessons which she
13 applied to the modified basketball shot: “think positively about the shot, believe I am going
14 to do well, take a deep breath, don’t think about my shot and just do it without thinking”. In
15 total, four members of the control group credited their coaches with introducing strategies
16 to them, while three further members credited PE teachers, and two credited their fathers.

17 On average, statements relating to two of the steps included in the 5SA appeared in the
18 reports given by the control group participants.

SUCCESSFUL TRANSFER OF A LEARNING STRATEGY

1 Knowledge of the strategy

Following the acquisition phase, participants in the strategy group showed excellent recall of the strategy, with all 10 participants correctly explaining Readyng, Imagery, Focusing and Evaluating, while 9/10 participants correctly explained the Execution step. Following the transfer phase, recall of the strategy remained high, with all 10 participants correctly explaining Focusing, 9/10 correctly explaining Readyng, 8/10 Evaluating, and 7/10 for both Imagery and Execution. Interestingly, although the Execution step was omitted from three of the explanations of five step strategy, statements indicating the completion of this step (e.g., "I cleared my mind" participant 5) were present in the accounts of all 10 participants in the strategy group.

Discussion

Research in motor learning has established the value of learning strategies, and specifically the 5SA, to enhance the performance and learning of closed motor skills (Lidor, 2004; Lidor et al., 1999; Singer, 1988). The results from the acquisition phase of the current study support these findings, in that participants in the strategy group demonstrated superior performance on a novel task relative to participants in a control group. The findings from the transfer phase extend previous research. After an interval of one month, participants who had been taught the strategy performed better on a second novel sporting

SUCCESSFUL TRANSFER OF A LEARNING STRATEGY

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1 task than participants in the control group. When questioned, participants in the
2 experimental group reported using the majority of the steps in the 5SA. These findings
3 suggest that physical education courses may benefit from explicitly teaching the 5SA, as
4 students will be able to learn more effectively on subsequent tasks.

5 A learning strategy is a specific combination of tools (e.g., relaxation techniques,
6 imagery, self-talk, etc) which a learner employs with the aim of enhancing practice quality
7 and eventual skill mastery. The 5SA represents one such combination of tools, presented in
8 a framework which learners appear to be able to transfer between skills. The exception to
9 this statement is the fact that only half of the participants in the strategy group reported
10 using imagery on the transfer task, despite the fact that 7/10 participants included the step
11 in their recollection. Within sport psychology interventions, it is common practice to assess
12 imagery ability and to either exclude or offer developmental support to individuals
13 reporting particularly low scores (Callow, Hardy, & Hall, 2001; Cumming & Ramsey,
14 2009). It may be that some participants in the current study struggled to obtain a clear and
15 useful image, and therefore omitted this step from their practice. It may be useful for future
16 studies on the 5SA to include an initial measure of imagery ability (e.g., the Movement
17 Imagery Questionnaire-Revised second version, Gregg, Hall, & Butler, 2010) and to
18 measure the quality of imagery use in addition to quantity.

SUCCESSFUL TRANSFER OF A LEARNING STRATEGY

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10 1 The dropping of the imagery step from the strategy is one example of how
11 2 participants adapted the 5SA that was presented to them. Reports reveal that participants
12 3 also altered the order of the steps, and repeated some steps (e.g., readying, focusing)
13 4 without being prompted to do so. These findings raise questions over the necessity of
14 5 strictly following the sequence of steps presented by Singer and Cauraugh (1985).
15 6 Furthermore, although the participants commonly reported using the generic steps of
16 7 readying, focusing, etc., the specific content of each individual's step differed. For
17 8 example, different participants reported readying as consisting of taking one deep breath or
18 9 two, bouncing the ball or spinning the ball in the hand. As pointed out by an anonymous
19 10 reviewer, the specific step sequence of the 5SA may provide a checklist-like mnemonic that
20 11 facilitates the initial adoption and internalization of the strategy. However, over a longer
21 12 time period, the 5SA may provide a metacognitive framework to support a learner to
22 13 develop his/her own unique learning strategy.

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40 14 The analysis of the reports provided by participants in the control group supports
41 15 the proposition of Anderson (2001): "The problem is not that students do not think; it is
42 16 that children may not think about the 'right' thing" (p. 14). Participants in the control group
43 17 did report using learning strategies, but these strategies were far less sophisticated than the
44 18 5SA, typically comprising of only one or two steps. In addition, the reports provided by
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SUCCESSFUL TRANSFER OF A LEARNING STRATEGY

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1 participants in the control group were more focused on specific aspects of technique during
2 the execution of the skill (e.g., “extend my shoulders”, “keep elbows soft”) relative to
3 participants in the strategy group. This focus on technique, and specifically on aspects of
4 technique linked to an internal focus of attention (Wulf, 2013) may be a feature of athletes
5 generally (Christina & Alpenfels, 2014; Porter, Wu, & Partridge, 2010), although there is a
6 paucity of investigations into the attentional focus participants adopt in natural conditions.
7 Alternatively, it is possible that the initial introduction to the underarm basketball free
8 throw provided to participants in the control group may have over-emphasised
9 biomechanical positions resulting in participants in the control group becoming excessively
10 focused on specific aspects of technique, thereby impeding their progress. Returning to
11 Anderson’s (2001) point, it appears that if learners are not taught to develop sophisticated
12 learning strategies, they will likely implement their own, suboptimal strategies.

13 A limitation of the current study is that participants were drawn from the same
14 school. As such, the possibility for “contamination” between the groups is high. However,
15 participants in the control group credited coaches, teachers or fathers with having
16 introduced the specific mental strategies used, and reported that they routinely applied these
17 strategies in their sports, such as batting in cricket or shooting in netball. Identifying
18 specific sources for their strategies suggests that the effects of any contamination were

SUCCESSFUL TRANSFER OF A LEARNING STRATEGY

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10 1 minimal, with participants in the control group continuing to rely upon strategies that they
11 2 had been introduced to in other domains. A second limitation of the current study was the
12 3 reliance upon self-report to confirm strategy use. The generation of detailed descriptions of
13 4 the strategies used potentially mitigates this concern, however the application of an
14 5 additional manipulation check, such as measuring preparation time (Lidor, 2004; Singer et
15 6 al., 1989), would have increased confidence in the self-reports. The small sample size
16 7 allowed the researcher to work effectively with the participants in delivering the
17 8 intervention; however, group differences must be interpreted cautiously in terms of their
18 9 generalizability. Finally, while a one month interval is a considerable improvement over the
19 10 time intervals between strategy acquisition and transfer test used by previous studies,
20 11 questions remain as to whether the strategy would be retained and utilized over longer
21 12 intervals.

13 In conclusion, while secondary school students appeared to make use of
14 rudimentary learning strategies, teaching a more sophisticated strategy had beneficial
15 results for learning novel skills. Participants were able to retain their knowledge of the 5SA
16 over a one-month period, and, unprompted, to transfer use of this strategy to a novel skill.
17 Furthermore, participants made adaptations to the content, order and inclusion of certain
18 steps of the 5SA to generate an individualized learning strategy. Presenting the 5SA as a

SUCCESSFUL TRANSFER OF A LEARNING STRATEGY

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- 1 flexible framework appears to be a sensible approach, although future research should
- 2 confirm whether student-modified strategies are superior to teacher-imposed strategies. PE
- 3 teachers and coaches working with adolescents should consider introducing the 5SA as a
- 4 means of empowering learners and enhancing learning efficacy.

For Peer Review

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1 Table 1

2 *Comparison of median performance (points) of the strategy and control groups across the*
3 *acquisition and transfer tasks.*

Task	Basketball (points)			Golf (points)	
	Pre-test	Day 1	Day 2	Day 3	Transfer
Strategy	2.3 (0.38)	2.7 (0.51)	2.7 (0.22)	2.9 (0.23)	5.3 (0.46)
Control	2.4 (0.83)	2.3 (0.63)	2.3 (0.38)	2.5 (0.33)	4.9 (0.76)

4 *Note:* Values in brackets refer to inter-quartile ranges. The maximum score obtainable on
5 the basketball task was 5 points. The maximum score obtainable on the golf task was 10
6 points.

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SUCCESSFUL TRANSFER OF A LEARNING STRATEGY

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1 **Figure 1.** The design of the study.

2 *The first set of 10 trials was used to familiarize participants with the task, and was not
3 analysed.

4
5 **Figure 2.** Strategy use reported by each group during the acquisition and transfer phases.

6 AP: Acquisition Phase. TP: Transfer Phase.
7

Session	Session 1a	Session 1b	Session 2	Session 3	One month interval	Session 4
Content of session	Baseline data	Briefing on strategy/technique and practice				Transfer test
Practice (sets x trials)	(2 x 10)*	(3 x 10)	(3 x 10)	(3 x 10)		(4 x 10)*

Figure 1. The design of the study.

*The first set of 10 trials was used to familiarize participants with the task, and was not analysed.

51x8mm (300 x 300 DPI)

For Peer Review

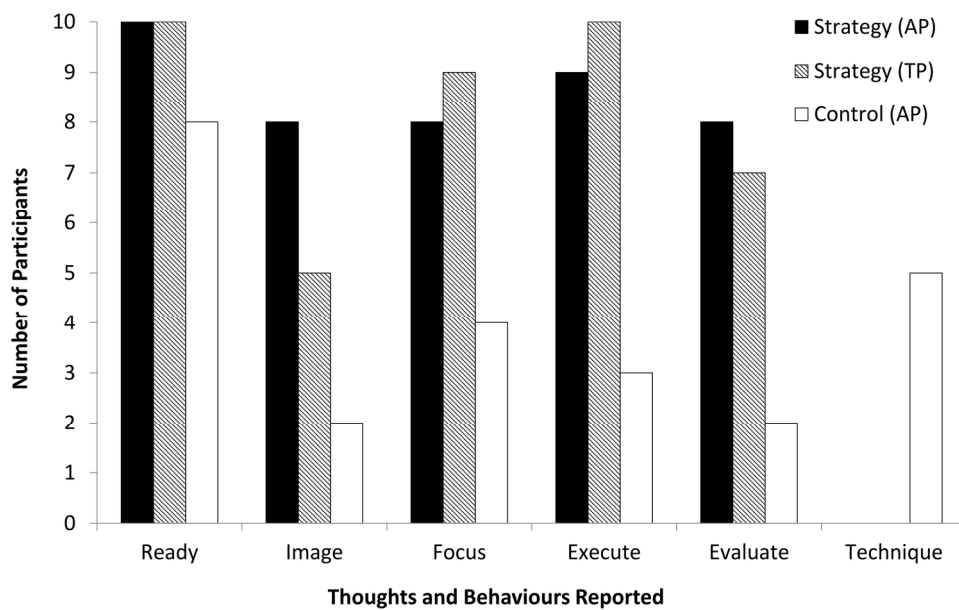


Figure 2. Strategy use reported by each group during the acquisition and transfer phases. AP: Acquisition Phase. TP: Transfer Phase.

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